

PRELIMINARY DATA SUMMARY

May 1990

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

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CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

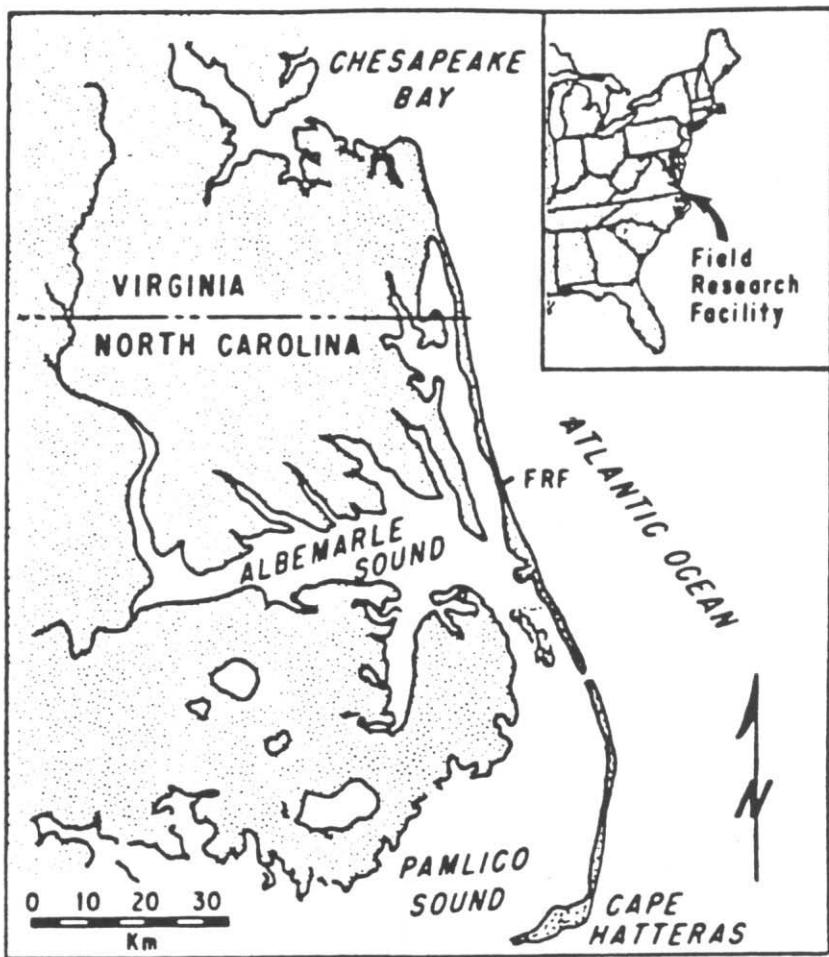


Figure 1. FRF location map

**Table 1: Instrument Status/Data Availability**

MAY 1990

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

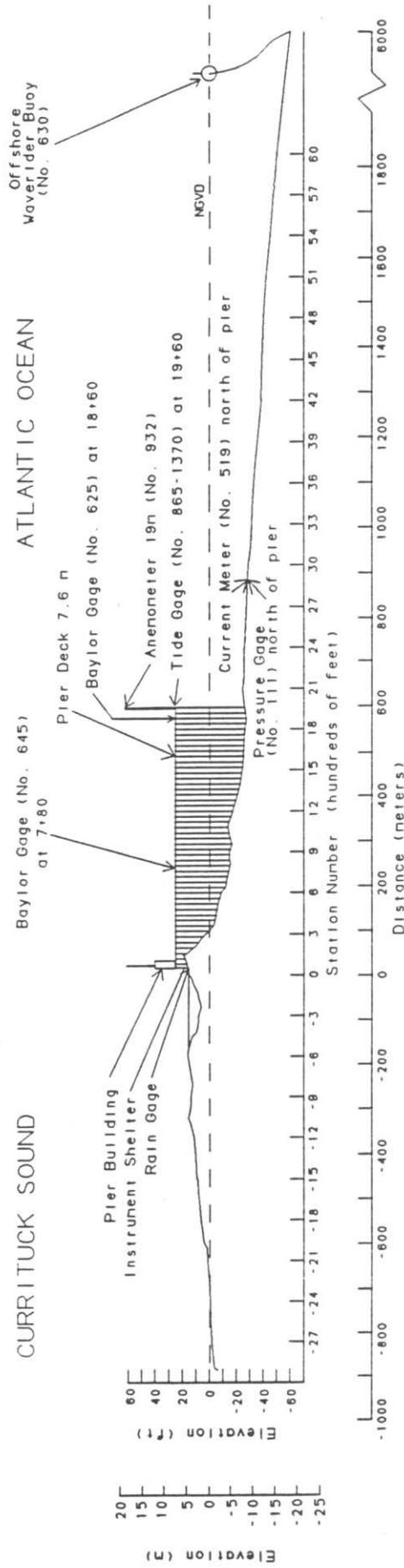
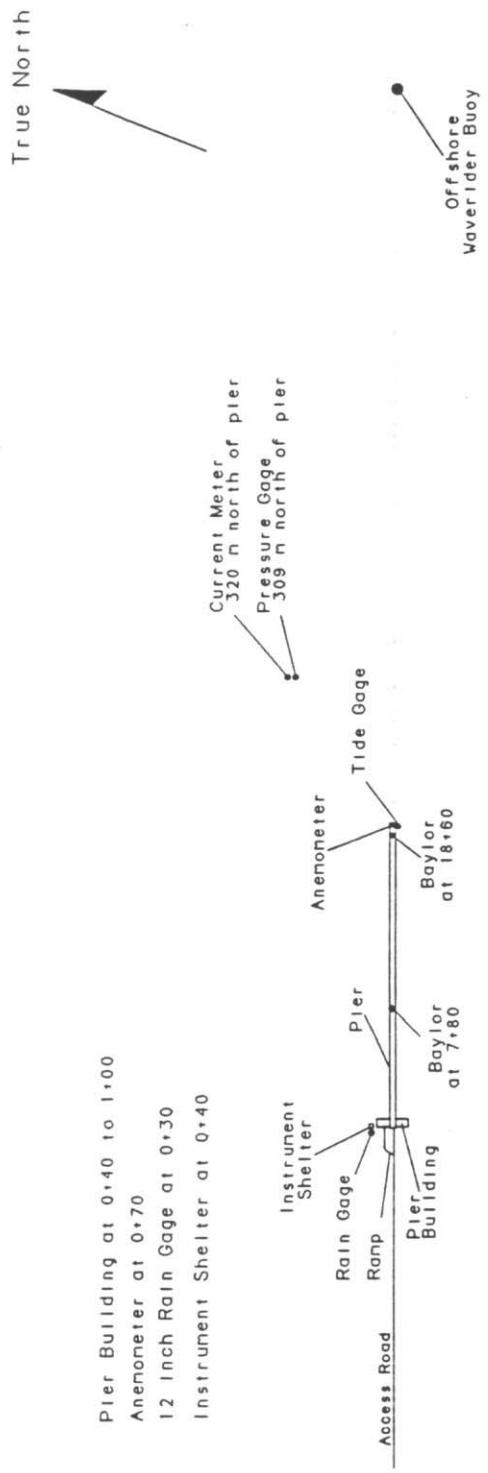


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $m/s \times 1.943 = kn$

Table 2: Meteorological Data

May 1990

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	88	15.9	1011.1	0
	700	2	79	17.4	1012.8	0
	1300	3	193	23.8	1012.1	0
	1900	5	165	19.7	1011.1	0
2	100	4	276	22.1	1011.1	0
	700	7	343	16.3	1015.9	0
	1300	8	20	17.9	1018.9	0
	1900	6	62	15.6	1020.3	0
3	100	4	93	15.6	1021.6	0
	700	7	45	16.3	1023.3	0
	1300	8	57	16.2	1024.0	0
	1900	8	53	15.8	1023.6	0
4	100	6	124	17.5	1021.3	4
	700	1	147	17.6	1021.3	0
	1300	5	111	20.1	1017.9	0
	1900	8	197	22.5	1013.8	0
5	100	11	208	22.2	1009.4	0
	700	11	222	23.0	1006.7	0
	1300	11	240	26.3	1003.0	0
	1900	10	229	22.1	1001.0	0
6	100	5	327	16.4	1003.0	14
	700	10	332	13.3	1007.7	0
	1300	3	28	14.9	1009.8	0
	1900	3	149	13.5	1010.1	0
7	100	5	240	16.0	1011.1	0
	700	8	320	15.6	1014.5	0
	1300	5	26	17.0	1015.9	0
	1900	6	176	16.6	1015.9	0
8	100	7	221	17.3	1016.9	0
	700	6	249	18.6	1018.9	0
	1300	5	244	24.4	1018.6	0
	1900	8	200	21.9	1017.2	0
9	100	6	220	18.9	1018.2	0
	700	7	228	20.0	1019.6	0
	1300	8	205	25.5	1018.2	0
	1900	9	190	21.4	1016.2	0
10	100	10	181	20.9	1012.8	0
	700	10	174	20.9	1008.4	0
	1300	14	181	21.4	1002.6	4
	1900	12	197	22.6	998.9	8
11	100	9	273	14.8	1007.7	4
	700	8	272	14.8	1012.8	0
	1300	6	252	19.4	1014.5	0
	1900	3	271	18.7	1016.9	0
12	100	4	158	15.4	1019.6	0
	700	5	46	15.5	1022.3	0
	1300	5	104	17.6	1023.0	0
	1900	8	171	19.3	1020.6	0
13	100	6	174	18.9	1018.2	0
	700	7	185	20.6	1017.2	0
	1300	10	178	25.2	1013.5	0
	1900	9	209	21.6	1011.8	8
14	100	6	245	21.3	1012.5	0
	700	8	353	15.0	1016.2	0
	1300	5	26	16.8	1018.2	0
	1900	6	40	14.7	1018.9	0
15	100	4	58	13.6	1019.2	0
	700	4	3	14.3	1020.3	0
	1300	4	59	17.3	1019.9	0
	1900	6	124	16.0	1018.9	0
16	100	4	190	18.5	1017.9	0
	700	5	205	20.9	1017.5	0
	1300	6	216	28.2	1015.9	0
	1900	9	187	23.7	1013.1	0

\* electronic problems

(Continued)

Table 2: Meteorological Data

May 1990

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed m/sec	Direction deg TN	deg C	mb	mm
17	100	8	206	22.2	1011.1	0
	700	9	222	23.4	1010.4	0
	1300	8	231	29.2	1006.7	0
	1900	8	227	24.1	1006.4	0
18	100	7	289	21.9	1009.1	0
	700	7	293	20.4	1012.8	0
	1300	10	230	23.1	1011.8	0
	1900	7	243	22.6	1011.4	0
19	100	7	277	20.1	1013.1	0
	700	5	285	20.7	1015.9	0
	1300	7	223	26.6	1014.5	0
	1900	5	196	23.7	1013.5	0
20	100	8	225	21.8	1012.8	0
	700	7	235	21.0	1013.1	0
	1300	8	196	28.0	1010.8	0
	1900	10	194	22.9	1008.7	0
21	100	9	222	22.6	1006.4	0
	700	11	237	23.3	1005.7	0
	1300	3	92	21.3	1006.7	0
	1900	8	38	16.4	1009.4	0
22	100	11	43	14.5	1009.8	0
	700	11	43	13.4	1009.8	18
	1300	13	36	14.0	1008.7	14
	1900	16	27	12.7	1008.4	6
23	100	13	23	13.3	1009.4	7
	700	10	13	13.9	1011.8	0
	1300	4	33	15.8	1012.8	0
	1900	5	4	16.3	1013.5	0
24	100	4	249	15.5	1014.2	0
	700	5	273	17.4	1014.8	0
	1300	5	99	20.6	1014.8	0
	1900	5	160	15.4	1016.2	3
25	100	4	199	16.2	1017.2	0
	700	1	327	18.4	1018.6	0
	1300	5	102	19.9	1019.2	0
	1900	5	153	18.2	1018.2	0
26	100	3	163	17.6	1016.9	0
	700	7	211	20.8	1014.2	0
	1300	10	225	25.6	1011.1	0
	1900	10	209	23.2	1007.0	0
27	100	11	237	21.9	1005.4	0
	700	7	288	20.0	1006.4	0
	1300	8	21	15.8	1008.7	0
	1900	7	40	15.2	1009.8	0
28	100	5	65	14.6	1009.8	0
	700	9	70	15.0	1010.8	0
	1300	10	66	15.8	1009.1	0
	1900	9	71	16.1	1007.0	10
29	100	5	133	17.8	1003.7	21
	700	6	160	18.5	999.6	25
	1300	6	248	24.0	996.9	14
	1900	10	303	19.6	998.6	0
30	100	9	318	16.4	1002.3	0
	700	10	337	15.3	1007.4	0
	1300	6	24	18.7	1010.4	0
	1900	2	103	16.9	1013.5	0
31	100	2	160	16.4	1015.9	0
	700	2	226	19.8	1019.2	0
	1300	4	46	19.1	1019.9	0
	1900	4	81	17.1	1019.2	0
		Resultant		Mean	Mean	Total
		1	215	19.0	1013.0	160

\* electronic problems

(Sheet 2 of 2)

### PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

May 1990

Day	Hour	645		625		111		630	
		Baylor	at 7+80	Baylor	at 18+60	Pressure	Gage	Offshr	Wvrdr
		Hmo,m	T,sec	Hmo,m	T,sec	Hmo,m	T,sec	Hmo,m	T,sec
1	0100	0.54	7.53	0.65	8.83	0.77	7.11	0.85	6.74
	0700	0.41	8.26	0.64	8.26	0.67	7.76	0.72	7.53
	1300	0.47	8.53	0.68	8.53	0.76	8.53	0.79	8.00
	1900	0.43	8.26	0.62	7.53	0.71	8.26	0.72	8.00
2	0100	0.42	14.22	0.61	14.22	0.66	14.22	0.69	14.22
	0700	0.49	13.47	0.68	13.47	0.72	12.19	0.71	12.80
	1300	0.82	3.82	0.99	12.19	1.07	14.22	1.11	14.22
	1900	0.74	4.13	0.94	12.19	0.97	12.80	1.02	12.80
3	0100	0.58	14.22	0.86	13.47	0.88	13.47	0.97	13.47
	0700	0.69	14.22	0.88	14.22	0.82	13.47	0.91	14.22
	1300	0.82	4.00	1.06	4.20	1.08	3.77	1.09	3.88
	1900	0.76	4.49	0.94	4.49	0.92	4.41	1.04	4.20
4	0100	0.61	4.92	0.83	4.49	0.89	5.02	0.93	5.33
	0700	0.52	12.80	0.75	12.19	0.81	12.80	0.90	4.49
	1300	0.51	5.12	0.71	4.92	0.77	5.02	0.88	4.92
	1900	0.44	5.02	0.61	12.80	0.69	11.64	0.85	5.02
5	0100	0.41	12.19	0.57	12.19	0.63	12.80	0.95	5.22
	0700	0.34	12.19	0.45	12.19	0.52	11.64	0.68	12.19
	1300	0.28	7.53	0.40	12.19	0.46	7.76	0.77	7.11
	1900	0.38	7.76	0.50	7.53	0.55	7.76	0.59	8.00
6	0100	0.24	7.53	0.32	7.76	0.37	11.13	0.45	12.19
	0700	1.15	5.69	1.00	5.33	1.15	5.33	1.53	5.57
	1300	1.01	5.95	0.87	5.82	0.94	5.95	1.05	5.69
	1900	0.61	5.57	0.59	5.33	0.64	5.69	0.73	5.82
7	0100	0.44	5.95	0.46	11.13	0.56	11.64	0.58	8.83
	0700	0.44	5.69	0.53	11.64	0.57	8.00	0.73	6.09
	1300	0.47	6.40	0.53	6.56	0.59	6.40	0.77	6.40
	1900	0.28	11.64	0.41	10.67	0.41	8.00	0.56	7.53
8	0100	0.24	10.24	0.40	6.74	0.40	9.14	0.47	6.74
	0700	0.17	9.85	0.29	9.85	0.34	9.48	0.37	9.14
	1300	0.17	9.85	0.27	8.53	0.30	9.14	0.31	9.85
	1900	0.33	3.88	0.41	3.61	0.45	3.82	0.57	4.06
9	0100	0.19	9.85	0.25	10.67	0.28	10.67	0.38	10.24
	0700	0.16	10.24	0.24	10.24	0.27	10.24	0.35	10.24
	1300	0.20	9.48	0.26	10.24	0.25	10.24	0.41	9.85
	1900	0.24	3.37	0.31	8.83	0.31	3.51	0.60	3.61
10	0100	0.30	2.10	0.33	9.48	0.28	9.48	0.53	3.12
	0700	0.39	2.75	0.48	6.74	0.41	7.11	0.71	5.95
	1300	0.94	3.94	0.92	7.31	1.00	3.28	1.13	7.11
	1900	0.76	8.26	0.88	9.14	1.00	7.76	1.23	7.53
11	0100	0.44	9.14	0.59	9.48	0.60	8.26	0.79	8.83
	0700	0.29	9.14	0.43	9.48	0.50	9.14	0.72	8.83
	1300	0.32	8.53	0.47	8.53	0.46	8.53	0.56	8.26
	1900	0.33	7.53	0.41	8.00	0.57	7.53	0.56	7.53
12	0100	0.32	9.14	0.47	9.48	0.53	8.53	0.56	8.53
	0700	0.29	8.00	0.47	8.26	0.61	8.26	0.61	8.00
	1300	0.81	4.66	0.95	8.00	0.95	8.26	1.11	4.74
	1900	0.74	5.95	0.86	8.26	0.95	8.26	1.09	8.53
13	0100	0.66	5.02	0.82	5.69	0.87	8.83	1.12	5.45
	0700	0.63	5.22	0.89	5.82	1.03	6.09	1.17	5.82
	1300	0.67	6.09	0.84	6.40	0.89	6.56	1.13	6.74
	1900	0.62	5.69	0.83	6.40	0.95	6.56	1.12	6.56
14	0100	0.48	6.92	0.67	6.74	0.80	7.53	0.96	6.40
	0700	0.46	7.31	0.62	7.31	0.62	6.74	0.83	7.11
	1300	0.65	5.12	0.70	4.83	0.79	5.02	0.95	4.83
	1900	0.53	4.20	0.72	7.31	0.74	4.13	0.90	7.11
15	0100	0.51	3.77	0.68	4.06	0.68	4.00	0.85	8.26
	0700	0.51	4.49	0.67	6.92	0.71	4.20	0.84	7.11
	1300	0.47	5.33	0.67	8.83	0.66	7.76	0.76	8.53
	1900	0.44	5.12	0.64	7.31	0.71	5.57	0.75	6.40
16	0100	0.38	8.53	0.55	7.76	0.61	8.00	0.68	8.53
	0700	0.33	15.06	0.59	14.22	0.61	8.26	0.63	14.22
	1300	0.30	14.22	0.53	14.22	0.59	13.47	0.63	8.26
	1900	0.40	13.47	0.58	13.47	0.60	8.26	0.74	8.53

\* Electronic problems

(Continued)

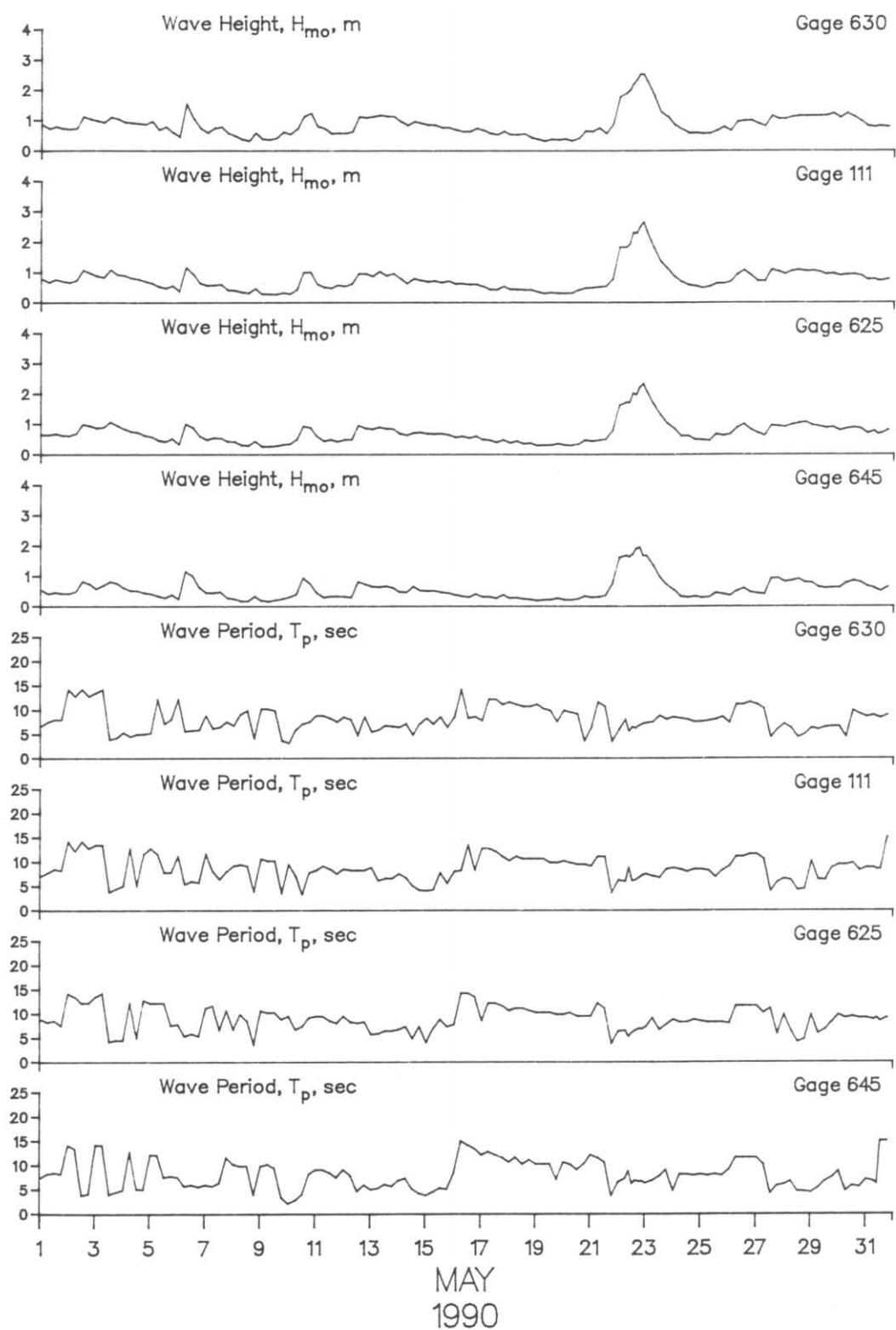
Table 3: Wave Data

May 1990

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo,m	Baylor at 18+60	Hmo,m	Pressure Gage	T.sec	Offshrd	Wvrdr
17	0100	0.31	12.19	0.48	8.53	0.52	12.80	0.67	7.76
	0700	0.31	12.80	0.45	12.19	0.42	12.80	0.56	12.19
	1300	0.26	12.19	0.38	12.19	0.42	12.19	0.52	12.19
	1900	0.37	11.64	0.46	11.64	0.53	11.13	0.63	11.13
18	0100	0.27	10.67	0.37	10.67	0.43	10.24	0.53	11.64
	0700	0.28	11.64	0.42	11.13	0.42	11.13	0.52	11.13
	1300	0.24	10.24	0.34	11.13	0.41	10.67	0.55	10.67
	1900	0.22	11.13	0.35	10.67	0.41	10.67	0.43	10.67
19	0100	0.18	10.24	0.28	10.24	0.35	10.67	0.37	11.13
	0700	0.20	10.24	0.28	10.24	0.29	10.67	0.31	10.24
	1300	0.22	10.24	0.28	10.24	0.32	9.85	0.37	9.85
	1900	0.27	7.11	0.35	9.85	0.30	9.85	0.35	7.53
20	0100	0.21	10.67	0.29	9.85	0.29	10.24	0.38	9.85
	0700	0.20	10.24	0.28	10.24	0.30	9.85	0.32	9.48
	1300	0.24	9.14	0.32	9.48	0.41	9.48	0.40	9.14
	1900	0.34	10.24	0.46	9.48	0.47	9.48	0.65	3.56
21	0100	0.29	12.19	0.42	9.48	0.48	9.14	0.64	6.24
	0700	0.30	11.64	0.46	12.19	0.51	11.13	0.74	11.64
	1300	0.35	10.67	0.49	11.13	0.53	11.13	0.57	10.67
	1900	0.74	3.61	0.77	3.77	0.77	3.61	0.86	3.46
22	0100	1.61	6.56	1.61	6.40	1.82	6.24	1.78	5.82
	0700	1.67	7.31	1.72	6.56	1.83	5.95	1.91	8.00
	1300	1.73	6.24	2.01	6.09	2.30	6.09	2.21	6.40
	1900	1.95	6.74	2.22	6.92	2.50	6.74	2.53	6.74
23	0100	1.67	6.40	2.08	7.31	2.34	7.53	2.31	7.31
	0700	1.34	6.92	1.65	9.14	1.82	7.11	1.83	7.53
	1300	0.95	7.76	1.30	6.74	1.36	6.74	1.28	8.83
	1900	0.70	9.14	1.01	7.76	1.12	8.53	1.12	8.00
24	0100	0.54	4.74	0.85	8.83	0.86	8.83	0.84	8.53
	0700	0.33	8.26	0.60	8.26	0.68	8.53	0.71	8.26
	1300	0.29	8.26	0.60	8.26	0.58	8.00	0.58	8.00
	1900	0.32	8.00	0.48	8.83	0.54	8.53	0.58	7.53
25	0100	0.28	8.26	0.46	8.53	0.48	8.53	0.55	7.53
	0700	0.30	8.00	0.44	8.26	0.53	8.26	0.56	7.76
	1300	0.44	8.26	0.66	8.26	0.63	6.92	0.65	8.00
	1900	0.40	8.00	0.61	8.26	0.63	8.26	0.78	8.53
26	0100	0.35	9.14	0.66	8.00	0.68	9.14	0.66	7.31
	0700	0.51	11.64	0.88	11.64	0.93	11.13	0.96	11.13
	1300	0.60	11.64	1.00	11.64	1.07	11.13	0.99	11.13
	1900	0.47	11.64	0.81	11.64	0.91	11.64	1.01	11.64
27	0100	0.43	11.64	0.70	11.64	0.71	11.64	0.89	11.13
	0700	0.39	10.24	0.61	10.24	0.70	10.67	0.81	10.24
	1300	0.92	4.20	0.95	11.13	1.09	3.94	1.15	4.34
	1900	0.94	5.82	0.93	5.82	1.03	5.82	1.06	5.95
28	0100	0.81	6.09	0.90	9.85	0.95	6.56	1.05	7.11
	0700	0.84	6.74	0.98	6.56	1.05	6.24	1.12	6.24
	1300	0.90	4.66	1.03	4.13	1.09	4.20	1.15	4.27
	1900	0.79	4.57	1.06	4.74	1.05	4.34	1.15	4.92
29	0100	0.77	4.41	0.96	9.85	1.05	10.24	1.16	6.24
	0700	0.63	5.33	0.92	5.95	1.03	6.40	1.16	5.95
	1300	0.60	6.74	0.86	6.74	0.94	6.24	1.17	6.40
	1900	0.61	7.53	0.89	8.26	0.96	8.83	1.24	6.56
30	0100	0.62	8.83	0.78	9.85	0.90	9.48	1.09	6.56
	0700	0.77	4.74	0.84	9.14	0.92	9.48	1.24	4.41
	1300	0.85	5.82	0.88	9.48	0.94	9.85	1.13	9.85
	1900	0.80	5.57	0.85	9.14	0.90	8.26	0.98	9.14
31	0100	0.67	7.11	0.69	9.14	0.76	8.83	0.81	8.53
	0700	0.60	6.74	0.76	8.83	0.77	8.83	0.78	8.83
	1300	0.51	15.06	0.68	8.53	0.72	8.53	0.81	8.26
	1900	0.62	15.06	0.79	9.14	0.77	15.06	0.79	8.83
Mean		0.54	8.12	0.70	8.89	0.75	8.57	0.85	8.06
Std dev		0.33	3.08	0.36	2.50	0.39	2.64	0.38	2.55

\* Electronic problems

(Sheet 2 of 2)



#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data  
May 1990

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter		
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
1	0100-Along Cross Result									2	N
1	0700-Along Cross Result	14 4 14	N on 323		152	8 1 8	N off 349	38	N	4	off
1	1300-Along Cross Result									4	43
1	1900-Along Cross Result									2	S
2	0100-Along Cross Result									1	on
2	0700-Along Cross Result	41 20 45	S on 187		152	9 0 9	N 340	20	N	4	284
2	1300-Along Cross Result									4	S
2	1900-Along Cross Result									1	off
3	0100-Along Cross Result									2	133
3	0700-Along Cross Result	18 4 18	S on 171		152	36 4 36	N on 334	24	N	8	N
3	1300-Along Cross Result									2	on
3	1900-Along Cross Result									9	327
4	0100-Along Cross Result									8	S
4	0700-Along Cross Result	21 9 23	S on 184		152	17 4 18	N on 326	56	N	7	off
4	1300-Along Cross Result									11	119
4	1900-Along Cross Result									20	S
5	0100-Along Cross Result									5	off
5	0700-Along Cross Result	14 14 20	N off 25		152	9 11 14	N off 31	59	N	21	146
5	1300-Along Cross Result									15	S
5	1900-Along Cross Result									8	off
										17	132
										10	S
										13	off
										16	108
										7	S
										0	
										7	
										3	
										1	
										1	
										5	
										5	
										5	261
										1	S
										7	on
										7	242
										3	N
										7	on
										8	273
										4	N
										6	on
										7	284

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)  
May 1990

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519				
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	Speed	Dir
6	0100-Along Cross Result									1	N		
6	0700-Along Cross Result	24 5 25	S on 171		140	87 22 90	S on 174		North	76	S	13 5 14	S off 139
6	1300-Along Cross Result									14	S		
6	1900-Along Cross Result									10	off		
6										17	124		
7	0100-Along Cross Result									4	S		
7	0700-Along Cross Result	36 0 36	S 160		140	34 0 34	S 160		North	33	S	7 7 10	S off 146
7	1300-Along Cross Result									15	S		
7	1900-Along Cross Result									12	off		
7										19	121		
8	0100-Along Cross Result									17	S		
8	0700-Along Cross Result	5 11 12	N off 46		140	3 8 8	N off 52		South	2	N	1 3 3	N on 268
8	1300-Along Cross Result									3	N		
8	1900-Along Cross Result									2	off		
8										4	14		
9	0100-Along Cross Result									3	N		
9	0700-Along Cross Result	7 13 14	N off 41		128	4 9 9	N off 46		South	3	N	1 2 2	S on 223
9	1300-Along Cross Result									3	N		
9	1900-Along Cross Result									3	on		
9										4	295		
10	0100-Along Cross Result									7	N		
10	0700-Along Cross Result	47 0 47	N 0 340		140	44 4 44	N on 334		South	86	N	6 6 9	N on 299
10	1300-Along Cross Result									25	N		
10	1900-Along Cross Result									11	on		
10										27	316		

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
May 1990

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter			
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
11	0100-Along Cross Result										5	S
11	0700-Along Cross Result	23 14 27	S off 129		152	8 15 17	S off 97		10 N		2 4 4	S on 223
11	1300-Along Cross Result										9 1 9	S on 166
11	1900-Along Cross Result										3 0 3	N 340
12	0100-Along Cross Result										1 3 3	S off 88
12	0700-Along Cross Result	5 0 5	S off 160		140	55 14 57	N on 326		13 N		1 0 1	S off 160
12	1300-Along Cross Result										8 5 9	S off 128
12	1900-Along Cross Result										2 3 4	N on 284
13	0100-Along Cross Result										4 5 6	N on 289
13	0700-Along Cross Result	22 11 24	N off 7		140	102 0 102	N 340		78 N		6 5 8	N on 300
13	1300-Along Cross Result										2 5 5	N on 272
13	1900-Along Cross Result										7 9 11	S on 212
14	0100-Along Cross Result										6 7 9	N on 291
14	0700-Along Cross Result	15 4 15	S on 174		140	13 10 17	N on 303		13 N		1 1 1	N off 25
14	1300-Along Cross Result										9 5 10	S off 131
14	1900-Along Cross Result										0 3 3	N off 70
15	0100-Along Cross Result										0 1 1	N on 250
15	0700-Along Cross Result	13 52 53	S on 236		140	21 7 22	N on 321		16 S		1 0 1	N off 340
15	1300-Along Cross Result										19 4 19	S off 148
15	1900-Along Cross Result										0 2 2	N on 250

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
May 1990

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter			
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	
16	0100-Along Cross Result									2	S	
										2	off	
										3	115	
16	0700-Along Cross Result	11 10 15	N on 298		140	29 0 29	N on 340		22 South	N	2	S
										3	on	
										4	216	
16	1300-Along Cross Result									1	S	
										1	on	
										1	205	
16	1900-Along Cross Result									4	N	
										4	on	
										6	295	
17	0100-Along Cross Result									6	N	
										8	on	
										10	287	
17	0700-Along Cross Result	27 27 37	N off 25		140	30 8 31	N on 326		21 South	N	4	N
										8	on	
										9	277	
17	1300-Along Cross Result									2	N	
										6	on	
										6	268	
17	1900-Along Cross Result									2	N	
										6	on	
										6	268	
18	0100-Along Cross Result									2	N	
										5	on	
										5	272	
18	0700-Along Cross Result	12 9 15	S on 197		140	0 24 24			9 North	S	4	S
										1	on	
										4	174	
18	1300-Along Cross Result									7	S	
										4	off	
										8	130	
18	1900-Along Cross Result									7	S	
										0		
										7	160	
19	0100-Along Cross Result									2	S	
										3	on	
										4	216	
19	0700-Along Cross Result	15 15 21	S off 115		128	34 14 36	N off 2		12 North	S	5	S
										0		
										5	160	
19	1300-Along Cross Result									12	S	
										1	off	
										12	155	
19	1900-Along Cross Result									16	S	
										8	off	
										18	133	
20	0100-Along Cross Result									3	N	
										5	on	
										6	281	
20	0700-Along Cross Result	0 13 13			140	6 2 7	N on 326		5 North	S	1	S
										1	on	
										1	205	
20	1300-Along Cross Result									6	S	
										2	on	
										6	178	
20	1900-Along Cross Result									11	S	
										1	on	
										11	165	

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S = Southward, Shore parallel  
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Table 4: Current Data (Continued)  
May 1990

Alongshore Cross-shore Resultant Time	Pier Measurements						Beach Measurements (500m Updrift)			Current Meter	
	Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)		Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519	
Day	Speed	Dir	Distance (m)	Speed	Dir				Speed	Dir	
21 0100-Along Cross Result									4	S	
21 0700-Along Cross Result	0 27 27		140	47 12 48	N on 326		10 N South		8 5 10	on on 189	
21 1300-Along Cross Result									9 10 11	S S 133	
21 1900-Along Cross Result									15 7 17	S off 135	
22 0100-Along Cross Result									34 15 37	S off 136	
22 0700-Along Cross Result	68 30 74	S on 184	177	87 131 157	S on 216		61 S North		39 17 43	S off 136	
22 1300-Along Cross Result									31 15 34	S off 134	
22 1900-Along Cross Result									40 15 43	S off 139	
23 0100-Along Cross Result									31 11 33	S off 140	
23 0700-Along Cross Result	34 15 37	S on 184	177	87 39 95	S on 184		30 S North		28 9 29	S off 142	
23 1300-Along Cross Result									19 4 19	S off 148	
23 1900-Along Cross Result									16 6 17	S off 139	
24 0100-Along Cross Result									22 4 22	S off 150	
24 0700-Along Cross Result	10 20 23	S off 97	140	4 7 8	N off 43		38 N South		13 3 13	S on 173	
24 1300-Along Cross Result									12 7 14	S off 130	
24 1900-Along Cross Result									14 4 15	S on 176	
25 0100-Along Cross Result									8 1 8	S on 167	
25 0700-Along Cross Result	5 1 5	S on 169	125	5 2 6	S on 177		15 S South		8 3 9	S on 181	
25 1300-Along Cross Result									25 8 26	S off 142	
25 1900-Along Cross Result									16 1 16	S on 164	

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)  
May 1990

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter			
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
26	0100-Along Cross Result								49	S	19	S
26	0700-Along Cross Result	15 4 16	N off 354		140	19 29 34	N off 36		North		13 4 14	S on 177
26	1300-Along Cross Result										7 8 11	S on 209
26	1900-Along Cross Result										2 11 11	S on 240
27	0100-Along Cross Result										11 7 13	S on 192
27	0700-Along Cross Result	14 27 30	S off 97		131	21 16 26	S on 197		34	S	8 4 9	S on 187
27	1300-Along Cross Result										28 9 29	S off 142
27	1900-Along Cross Result										22 12 25	S off 131
28	0100-Along Cross Result										17 6 18	S off 141
28	0700-Along Cross Result	0 0 0			134	18 0 18	S North 160		20	S	11 1 11	S off 155
28	1300-Along Cross Result										14 4 15	S off 144
28	1900-Along Cross Result										7 1 7	S on 168
29	0100-Along Cross Result										13 4 14	S off 143
29	0700-Along Cross Result	18 0 18	N 0 340		134	44 0 44	N North 340		32	N	12 1 12	S on 165
29	1300-Along Cross Result										11 0 11	S 0 160
29	1900-Along Cross Result										11 6 13	S off 131
30	0100-Along Cross Result										20 10 22	S off 133
30	0700-Along Cross Result	41 0 41	S 0 160		148	61 18 64	S off 143		40	S	26 6 27	S off 147
30	1300-Along Cross Result										25 6 26	S off 147
30	1900-Along Cross Result										17 5 18	S off 144

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Concluded)  
May 1990

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
	Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519
31 0100-Along Cross Result									17
									S
									5
									off
									18
									144
31 0700-Along Cross Result	4	S			17	N	20	S	16
	3	off	143		0		South		5
	5	125			17	340			off
									17
									143
31 1300-Along Cross Result									19
									S
									10
									off
									21
									132
31 1900-Along Cross Result									16
									S
									8
									off
									18
									133

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

#### PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

May 1990

Day	Time	Wave Approach		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0639	55	115		61	17.2	1.0211	4.3
2	0748	90			72	13.9	1.0241	2.4
3	0742	75		80	98	16.7	1.0217	4.0
4	0743	80	105		76	17.2	1.0198	2.7
5	0923	90	140		55	13.3	1.0240	3.7
6	0835	40		45	94	12.2	1.0254	2.4
7	0734	80			49	15.0	1.0236	3.7
8	0643	90	130		11	15.6	1.0223	3.7
9	0800	105			9	15.6	1.0230	4.3
10	0808	115			37	13.6	1.0246	2.1
11	0743	75	355		27	13.3	1.0250	3.4
12	1010	100	40	95	58	13.9	1.0245	3.4
13	1014	85	110		62	13.9	1.0242	3.0
14	0735	100	25		58	13.3	1.0245	3.4
15	0808	95	20		55	16.1	1.0242	4.3
16	0739	85	55		55	16.7	1.0220	3.0
17	0814	85	135		46	14.4	1.0243	3.4
18	0830	65	10		41	14.4	1.0252	3.4
19	0733	70			15	14.4	1.0245	2.7
20	0705	none visible			18	15.6	1.0238	2.7
21	0809	80			46	14.4	1.0244	4.0
22	0645	40		35	162	15.8	1.0242	1.5
23	0751	40		40	192	16.1	1.0206	1.2
24	0755	65			52	18.3	1.0202	2.1
25	0720	60			18	17.2	1.0202	3.0
26	0652	80	140		58	16.7	1.0210	3.0
27	0706	80	0		41	16.1	1.0234	1.8
28	0705	50		65	70	16.1	1.0234	3.0
29	0739	70	120		64	16.7	1.0226	3.0
30	0720	40		45	67	16.7	1.0217	3.4
31	0734	55			58	16.9	1.0204	5.5

## PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

## FRF Tide Heights

May 1990

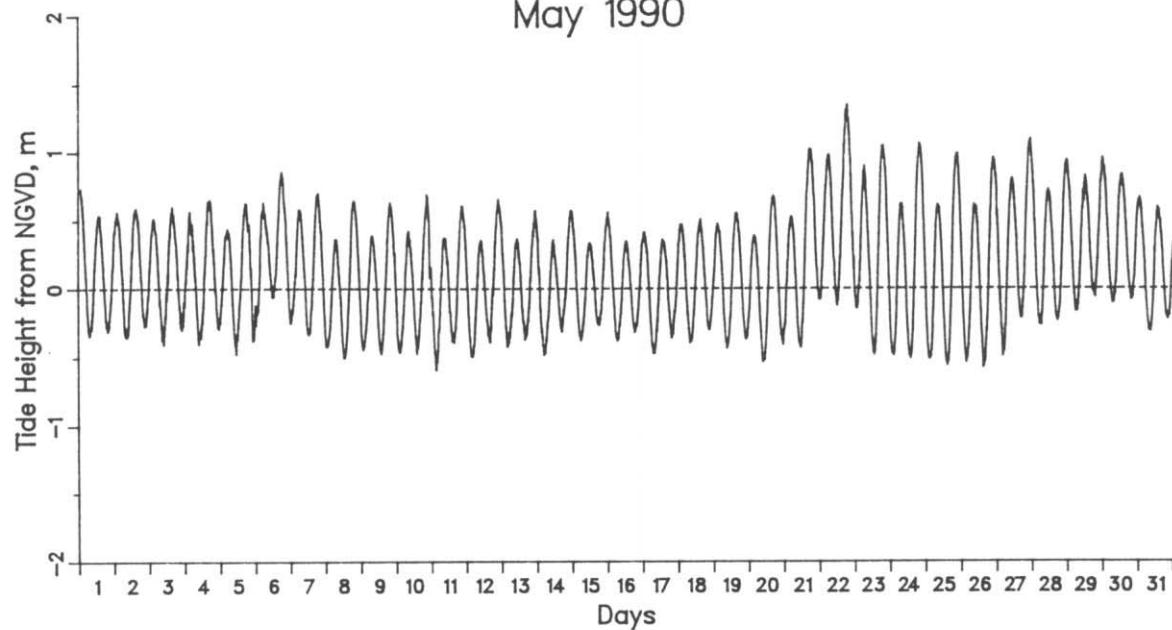


Figure 4. Water Level Time History

### Monthly Water Levels, m NGVD

Extreme Low = -0.59 on day 11 at 212 EST  
Extreme High = 1.35 on day 22 at 1754 EST  
Monthly Mean = 0.15  
Mean Low = -0.36  
Mean High = 0.74  
Mean Range = 1.10

Table 6: Water Levels, m NGVD

		May 1990			
Day	Mid-Cycle Time	Low	High	Mean	Range
1	612	-0.34	0.74	0.15	1.08
1	1837	-0.31	0.54	0.12	0.85
2	703	-0.35	0.57	0.10	0.92
2	1928	-0.27	0.59	0.16	0.86
3	753	-0.41	0.55	0.09	0.95
3	2018	-0.30	0.60	0.15	0.90
4	843	-0.40	0.62	0.08	1.02
4	2109	-0.29	0.65	0.16	0.94
5	934	-0.48	0.56	0.05	1.04
5	2159	-0.38	0.63	0.16	1.01
6	1024	-0.06	0.81	0.32	0.87
6	2249	-0.25	0.86	0.25	1.11
7	1115	-0.34	0.68	0.14	1.02
7	2340	-0.43	0.70	0.06	1.13
8	1205	-0.51	0.64	0.00	1.15
9	30	-0.45	0.65	0.05	1.09
9	1255	-0.48	0.63	0.03	1.11
10	121	-0.47	0.62	0.03	1.09
10	1346	-0.47	0.61	0.05	1.08
11	211	-0.59	0.69	-0.01	1.28
11	1436	-0.39	0.61	0.06	1.00
12	301	-0.49	0.56	-0.02	1.06
12	1527	-0.39	0.66	0.09	1.05
13	352	-0.42	0.60	0.03	1.02
13	1617	-0.37	0.57	0.05	0.94
14	442	-0.48	0.52	-0.04	1.00
14	1707	-0.31	0.57	0.10	0.89
15	532	-0.38	0.51	0.02	0.89
15	1758	-0.27	0.56	0.10	0.83
16	623	-0.38	0.48	0.01	0.87
16	1848	-0.32	0.41	0.04	0.73
17	713	-0.48	0.36	-0.05	0.83
17	1938	-0.36	0.47	0.06	0.83
18	804	-0.40	0.51	0.04	0.91
18	2029	-0.30	0.50	0.10	0.80
19	854	-0.44	0.56	0.05	0.99
19	2119	-0.37	0.54	0.06	0.91
20	944	-0.53	0.68	0.01	1.22
20	2210	-0.41	0.67	0.11	1.08
21	1035	-0.43	1.02	0.19	1.45
21	2300	-0.08	1.02	0.47	1.10
22	1125	-0.12	1.34	0.53	1.46
22	2350	-0.15	1.35	0.49	1.49
23	1216	-0.48	1.05	0.22	1.53
24	41	-0.49	1.05	0.17	1.53
24	1306	-0.51	1.06	0.18	1.57
25	131	-0.51	1.05	0.15	1.56
25	1356	-0.56	0.98	0.13	1.54
26	222	-0.54	0.99	0.15	1.53
26	1447	-0.58	0.96	0.13	1.54
27	312	-0.49	0.95	0.24	1.45
27	1537	-0.21	1.09	0.37	1.30
28	402	-0.27	1.10	0.32	1.37
28	1628	-0.23	0.92	0.29	1.16
29	453	-0.17	0.94	0.35	1.11
29	1718	-0.06	0.96	0.41	1.02
30	543	-0.10	0.94	0.37	1.05
30	1808	-0.08	0.84	0.35	0.92
31	634	-0.31	0.67	0.14	0.98
31	1859	-0.22	0.60	0.14	0.82

## PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in April and the two surveys in May on profile line 188, located 517 m south of the pier. The most significant change occurred on the nearshore bar (120 - 240 m) which first migrated 60 m shoreward followed by a 40 m seaward shift. Further offshore the storm bar (320 m) moved 40 m shoreward.

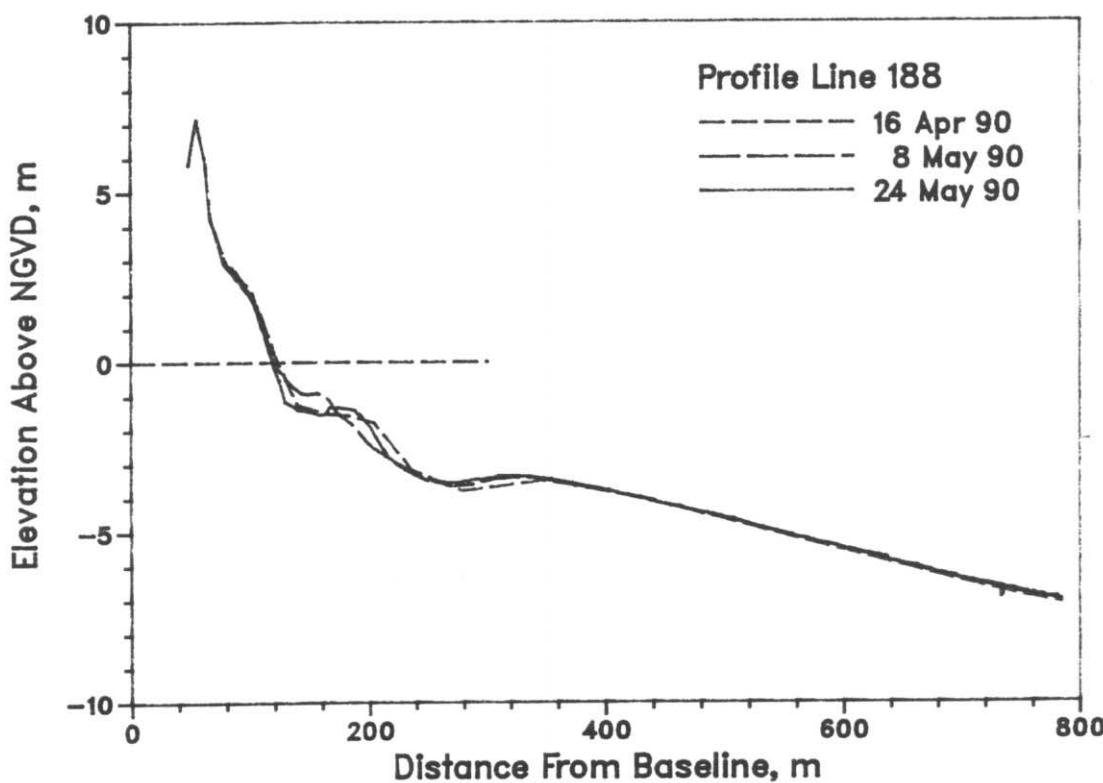


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1990. Causes for the changes visible on the envelope include the movement of the nearshore bar and trough (200 m) and the shoreward movement (300 m) of the offshore bar.

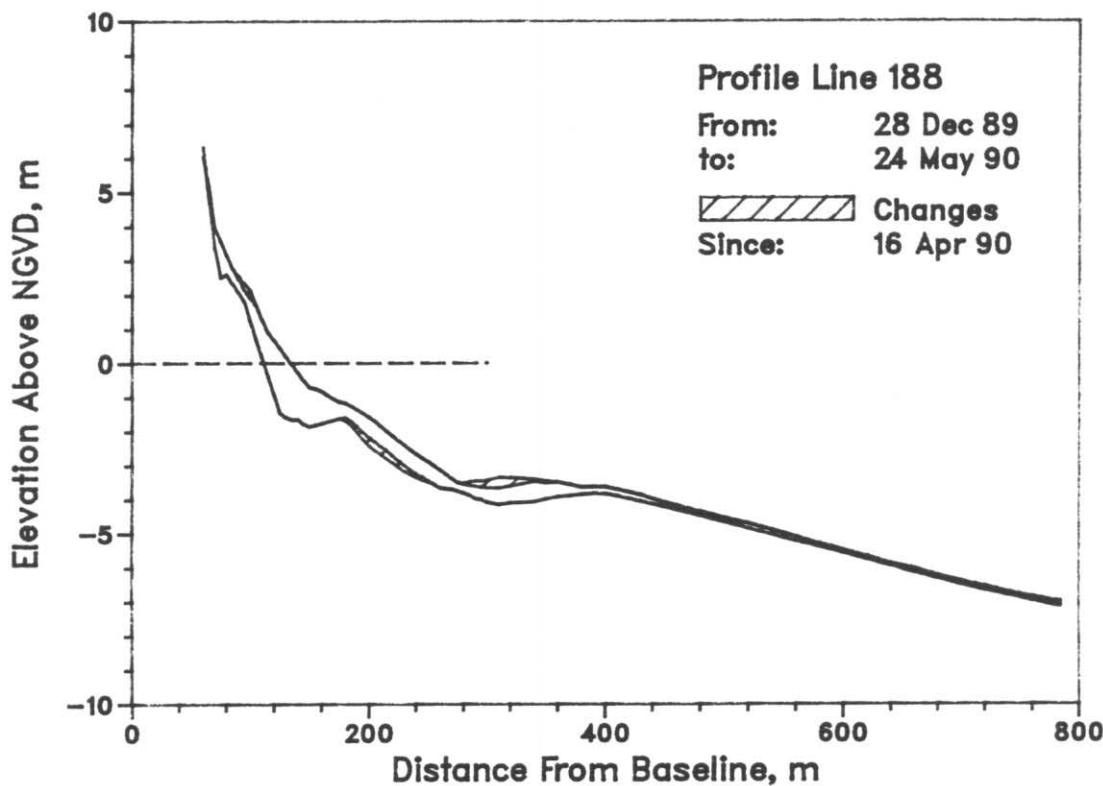


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 8 May 90. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

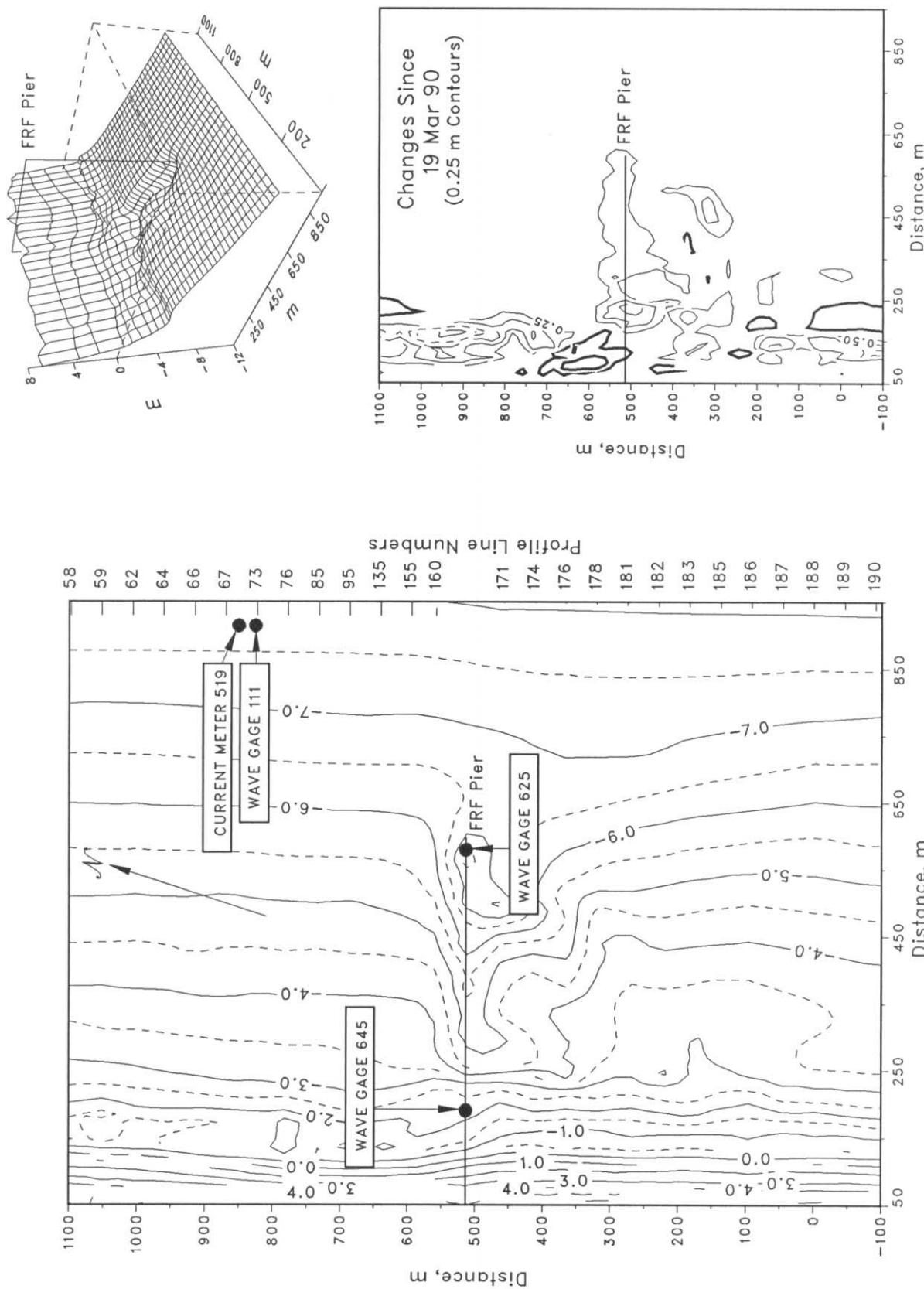


Figure 7. FRF bathymetry 8 May 90 depths relative to NGVD

## PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
22 May (1300)	23 May (0208)

### B. Storm Synopsis.

22-23 May - Travelling across the southern United States this storm went off the South Carolina coast early on 23 May. The maximum  $H_{mo}$  (at gage 625) of 2.33 m ( $T_p = 6.92$  sec) was attained at 2222 EST on 22 May. Preceeding this by several hours, the peak wind speed (from NE) exceeded 16 m/s. Because the storm track remained well south of the FRF the minimum atmospheric pressure only dropped to 1007.8 mb. Total precipitation was 45 mm.

### Distribution List

#### Government Agencies:

OCE	U.S. Geological Survey
BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
SAW	U.S. Naval Research Lab

#### Colleges/Universities:

California Inst. of Tech.	Stockton State College
East Carolina University	University of Akron
Florida Inst. of Tech.	University of Delaware
Harvard University	University of Florida
Naval Post Graduate School	University of Maryland
NC State University	University of Miami
Old Dominion University	University of North Carolina
Oregon State University	University of N. Colorado
Prince George's College	University of Rhode Island
Rutgers University	University of Virginia
Scripps Inst. of Oceanography	Va. Inst. of Marine Science
Southern Illinois University	

#### Others:

City of Va. Beach, VA	MEC Systems Corporation
Coastal Barge Corporation	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	Offshore Coastal Technologies
Coastal Science & Eng., Inc.	Mr. Rowland
Dr. Galvin	Mr. Savage
GEOMET Tech., Inc.	Sea Port Supply Corp.
Greenhorne & O'Mara, Inc.	Shell Development
Dr. Hylton	Sherwood Industries
Mary Marr, Inc.	Mr. & Mrs. Valpey
Mr. Mason	WCTI-TV
Masonite Corporation	SEASUN Power Systems

#### Foreign:

W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)  
Queen's University, Ontario (Canada)  
Ministry of Construction, Coastal Division (Japan)  
Norwegian Hydrodynamic Laboratories (Norway)  
University of New South Wales (Australia)  
University of Sydney (Australia)